Gold in the News

Tri-metallic Gold Nanocrystals

A solution-phase technique to make multimetallic nanocrystals of high structural complexity has been developed by chemistry Professor Raymond E. Schaak and his group at Texas A&M University.

The approach allows materials to be prepared at relatively low temperatures in only a few minutes compared to traditional solid-state reactions involving high-temperature sintering or melting that can take days or weeks to carry out. The technique has the potential to expand the availability of thin films, powders, and crystals of multimetal nanomaterials for applications in catalysis, magnetic storage, shape-memory alloys, and superconductivity.

The technique is a modification of standard nanocrystal synthesis methods. Schaak's group originally developed the process while working with gold and copper nanoparticles, which aggregate in solution to form nanocomposites that thermally transform at low temperatures into bimetallic nanocrystals. The composition of the compounds can be controlled by the ratio of reactants (*J. Am. Chem. Soc.* 2005, **127**, 3506). The researchers have found the process to be general and have extended it to make trimetallic $AuCuSn_2$ and $AuNiSn_2$ nanocrystals that have new structures not observed in bulk systems.

They prepared $AuCuSn_2$ by heating a solution of $HAuCl_4$, $Cu(C_2H_3O_2)_2$, $SnCl_2$, and poly(vinylpyrrolidone) in tetraethylene glycol to 70°C, then adding dilute $NaBH_4$ and heating to 120 to 200°C for 10 minutes. The multimetal materials, Schaak notes, are inherently impure because polymers and stabilizers are needed to form them, but his group has shown that the properties can be comparable to or better than higher purity materials made by high-temperature processes.

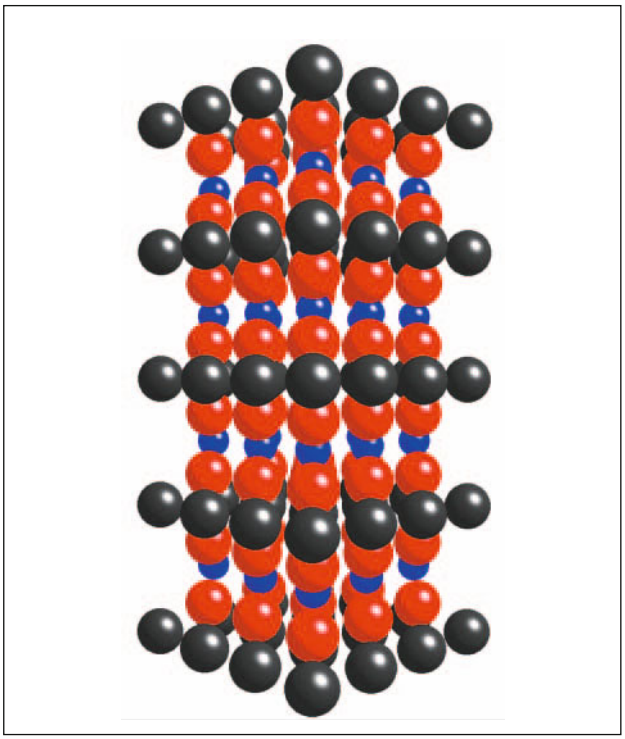
For more information see
http://pubs.acs.org/cen/news/83/i20/8320metallurgy.html

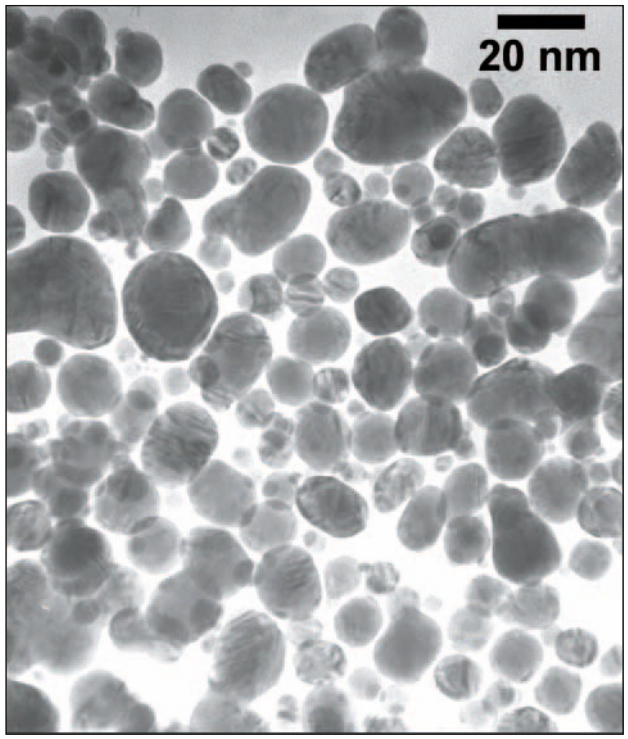
Gold-based Drugs Could Fight Malaria

A new leg of research being undertaken under the auspices of Project AuTEK involves investigations into the treatment of malaria with gold-based drugs. "This research is at an early stage but is expected to be very exciting," says Project AuTEK biomed head Dr Judy Caddy. The project is a South African-based collaboration between AngloGold Ashanti, Gold Fields, Harmony Gold and Mintek and, since its inception five years ago, some R30-million has been invested into research and development.

The impetus of the AuTEK biomedical programme has been on developing drug-delivery systems for gold-containing drugs, gold cationic complexes as potential antimitochondrial agents, mixed-metal chemotherapeutic drugs, radiolabelling and anti-HIV agents.

In the early 1990s some gold drugs were evaluated for activity against human immunodeficiency virus (HIV), and early results suggested that there might be some inhibition of HIV exhibited by gold compounds, such as sodium





Nanocrystals of $AuCuSn_2$ (shown in micrograph) prepared by solution processing are made up of alternating layers of gold atoms (grey) and copper atoms (blue), with tin atoms (red) occupying interstitial holes

aurothiomalate and aurothioglucose. Due to the biomed group having a variety of gold-based drugs within their consortium, a range of these compounds has been submitted for HIV screening, Caddy enthuses.

Project AuTEK biomed continues in its endeavours to find new industrial uses for gold in biomedicine. It began by investigating anti-tumour properties of gold (I)-based drugs.

The use of gold (I) drugs offers an advantage over the largest-selling anticancer drugs, platinum-based carboplatin and cisplatin, in that it has a mitochondrial mode of action, reports Caddy. The investigations in the biomed group have since expanded to include gold (III)-based drugs. Being isoelectronic and isostructural to platinum (II), gold (III)-based drugs are expected to have a similar mode of action to their platinum analogues, that is, targeting the DNA, offering an additional mode of action. For more information see http://www.engineeringnews.co.za/eng/news/breaking/?show=67605

Gold Catalyst selectively oxidizes carbon monoxide in hydrogen-rich gas feed

A catalyst consisting of gold nanocrystals supported on iron(III) oxide could potentially boost the efficiency of reformer technology. A reformer converts an organic fuel, such as methanol or a hydrocarbon, into hydrogen, which is then electrochemically oxidized by the fuel cell to generate electricity and water. Also produced in the reforming process are carbon dioxide, water, and carbon monoxide, a gas that poisons the platinum anode of the fuel cell.

"We have shown that gold, carefully prepared, is an effective catalyst for the preferential oxidation of CO in the presence of CO_2, H_2, and H_2O under realistic fuel-cell conditions," says Graham J. Hutchings, Chemistry Professor at Cardiff University, in Wales, who led the team that developed the catalyst.

Oxidation of CO in the presence of excess moist H_2 and CO_2 under industrially relevant conditions without oxidizing H_2 or regenerating CO from H_2 and CO_2 by the reverse water gas shift reaction is a difficult objective, the authors note. So far, it's been achieved only by using a multistage reactor, they say.

The researchers prepare the Au/Fe_2O_3 catalyst by coprecipitation of Au^{3+} and Fe_2O_3. Subsequent calcination converts the cationic gold, which catalyzes the reverse water gas shift reaction, to metallic gold. The calcination temperature has a crucial influence on the selective CO oxidation activity of the catalyst. Calcining the catalyst twice, at 400°C and 550°C, gives a catalyst that removes more than 99.5% of the CO in the presence of moist H_2 and CO_2 at 80°C, the operating temperature of the fuel cell.

"This is the first time that this tough target has been achieved," Hutchings explains.
For more information see
http://pubs.acs.org/cen/news/83/i23/8323notw7.html

Gold Catalyst Research Obtains Funding

Two recent funding announcements spell good news for gold catalysis research. Firstly, on August 8, 2005 President George W. Bush signed the wide-ranging Energy Policy Act of 2005, which while addressing U.S. energy needs, specifically creates a research program for the use of precious metals, including gold, in industrial catalysis. The precious metals provision is one aspect of a comprehensive federal program to conduct research and development in catalysis science.

In a further development it has been announced that The US Department of Energy has released funds to research the use of gold catalysts in the use of hydrogen fuelled fuel cell vehicles.

A University of Wyoming chemistry Professor has received a $300,000 grant as part of a project that will last for three years with emphasis on identifying and testing cheaper electrocatalysts for oxygen reduction. "……..catalysts needed to produce electricity from fuel cells are now very expensive," said Dan Buttry, who will lead UW efforts.

"Platinum is the only one that works now, and the process is slow and inefficient. Gold is less expensive and far more abundant than platinum," he added. The UW research is among 70 DOE-funded hydrogen research projects to achieve what is described as "revolutionary breakthroughs in hydrogen production and storage in addition to new fuel cell technologies".

Gold Helps in Arthritis Treatment

Gold therapy for the treatment of arthritis has been around for a while, and now new research shows it can be effective when combined with another treatment. In the study, reported in the journal *Arthritis and Rheumatism*, gold therapy reduced the severity of arthritis in patients who had a poor response with methotrexate, the standard drug used to treat the disease.

Findings from several observation studies have shown that gold can augment the treatment response seen with methotrexate, but until now, this has not been investigated in a study in which patients were randomly selected to receive gold or inactive "placebo" injections.

The study, which was conducted by Dr. John M. Esdaile, from the Arthritis Research Center of Canada in Vancouver, and colleagues, involved 65 patients who received weekly injections of gold or placebo.

At 48-week follow-up, significantly more gold-treated patients had experienced a treatment response than those given placebo. In addition, the gold therapy was found to be more cost-effective.

These results support previous findings indicating that combination therapy with gold and methotrexate is useful when the latter agent fails to provide an optimal response, the author's state.
New and effective drugs called TNF blockers have recently

become available for rheumatoid arthritis, but they are expensive. “Given the high costs of (newer anti-rheumatic drugs), we believe that there continues to be an important role for gold in combination with methotrexate, especially when cost is an issue,” Esdaile's team concludes.
For more information see http://www.reuters.com/news Article.jhtml?type=healthNews&storyID=8620112

Organically modified metal particles for the treatment of human hair

A new patent application from hair and beauty product manufacturer L’Oreal, France relates to the use of a suspension of organically modified metallic nanoparticles carrying on their surface a monolayer obtained from organosulfur compounds for the colouring and/or the treatment of human hair. Nanoparticles of gold modified by mercaptosuccinic acid were obtained by the treatment of $HAuCl_4.{}_3H_2O$ with mercaptosuccinic acid in the presence of $NaBH_4$ in aqueous MeOH solution. For extensive news of new patents see http://www.reuters.com/newsArticle.jhtml?type =healthNews&storyID=8620112